01-11-00

EL169869292

PTO/SB/05 (4/98)

Please type a plus sign (+) inside this box → [+]

Approved for use through 09/30/2000. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	MI40-274
First Inventor or Application Identifier	Rickie C. Lake
Title	See 1 in Addendum
Express Mail Label No.	EL169869292

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. [X] * Fee Transmittal Form *(e.g., PTO/SB/17)*
(Submit an original and a duplicate for fee processing)

2. [X] Specification [Total Pages 23]
(preferred arrangement set forth below)
- Descriptive title of the Invention
- Cross References to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to Microfiche Appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings *(if filed)*
- Detailed Description
- Claim(s)
- Abstract of the Disclosure

3. [X] Drawing(s) *(35 U.S.C. 113)* [Total Sheets 2]

4. Oath or Declaration [Total Pages 3]
a. [ ] Newly executed (original or copy)
b. [X] Copy from a prior application (37 C.F.R. § 1.63(d))
(for continuation/divisional with Box 16 completed)
i. [ ] DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

** NOTE FOR ITEMS 1 & 13 IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).*

5. [ ] Microfiche Computer Program *(Appendix)*

6. Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
a. [ ] Computer Readable Copy
b. [ ] Paper Copy (identical to computer copy)
c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. [ ] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [ ] Power of Attorney
9. [ ] English Translation Document *(if applicable)*
10. [X] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [X] Preliminary Amendment
12. [X] Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
13. [ ] * Small Entity Statement(s) *(PTO/SB/09-12)* [ ] Statement filed in prior application Status still proper and desired
14. [ ] Certified Copy of Priority Document(s)
(if foreign priority is claimed)
15. [X] Other: $1,098.00 check

16. **If a CONTINUING APPLICATION**, *check appropriate box, and supply the requisite information below and in a preliminary amendment:*
[ ] Continuation [X] Divisional [ ] Continuation-in-part (CIP) of prior application No: 09/022,812
Prior application information: Examiner T. Dove Group / Art Unit: 1745

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

[X] *Customer Number or Bar Code Label* 021567 *(Insert Customer No. or Attach bar code label here)* *or* [ ] *Correspondence address below*

Name					
Address					
City		State		Zip Code	
Country		Telephone		Fax	

Name (Print/Type)	Mark S. Matkin	Registration No. (Attorney/Agent)	32,268
Signature		Date	1-10-00

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231.

Addendum

1. Method of Conductively Interconnecting Electronic Components, Battery Powerable Apparatus, Radio Frequency Communication Device, and Electric Circuit

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Priority Application Serial No. 09/022,812
Priority Filing Date ..... February 12, 1998
Inventor ..... Rickie C. Lake
Assignee ..... Micron Technology, Inc.
Priority Group Art Unit 1745
Priority Examiner ..... T. Dove
Attorney's Docket No. MI40-274
Title: Method of Conductively Interconnecting Electronic Components, Battery Powerable Apparatus, Radio Frequency Communication Device, and Electric Circuit

PRELIMINARY AMENDMENT

To: Box PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

From: Mark S. Matkin (Tel. 509-624-4276; Fax 509-838-3424)
Wells, St. John, Roberts, Gregory & Matkin P.S.
601 W. First Avenue, Suite 1300
Spokane, WA 99201-3828

AMENDMENTS

In the Title

Please amend the title to read as:

--Method of Conductively Interconnecting Electronic Components, Battery Powerable Apparatus, Radio Frequency Communication Device, and Electric Circuit--.

In the Specification

At p. 1 before the "Technical Field" section, please insert the following:

--**RELATED PATENT DATA**

This patent resulted from a divisional application of U.S. Patent Application Serial No. 09/022,812, filed February 12, 1998, entitled "Thin Profile Battery Bonding Method and Method of Conductively Interconnecting Electronic Components" (As Amended), naming Rickie C. Lake as inventor, and which is now U.S. Patent No. _____, the disclosure of which is incorporated by reference.--

Delete the language starting on Page 9, line 20, starting with the word "Example" through Page 10, line 12 through "disclosures.", as directed to non-essential matter.

In the Claims

Cancel claims 1-8 and 15-22 without prejudice.

REMARKS

This application is a divisional application of U.S. Patent Application Serial No. 09/022,812. Claims 1-8 and 15-22 have been canceled without prejudice. Claims 9-14 and 23-50 remain in the application for consideration.

Respectfully submitted,

Dated: 1/10/00

By: _____

Mark S. Matkin
Reg. No. 32,268

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR LETTERS PATENT

* * * * *

Thin Profile Battery Bonding Method, Method Of Conductively Interconnecting Electronic Components, Battery Powerable Apparatus, Radio Frequency Communication Device, And Electric Circuit

* * * * *

INVENTOR

Rickie C. Lake

ATTORNEY'S DOCKET NO. MI40-123

Thin Profile Battery Bonding Method, Method Of Conductively Interconnecting Electronic Components, Battery Powerable Apparatus, Radio Frequency Communication Device, And Electric Circuit

TECHNICAL FIELD

This invention relates to thin profile battery bonding methods, to methods of conductively interconnecting electronic components, to battery powerable apparatus, to radio frequency communication devices, and to electric circuits.

BACKGROUND OF THE INVENTION

Thin profile batteries comprise batteries that have thickness dimensions which are less than a maximum linear dimension of its anode or cathode. One type of thin profile battery is a button type battery. Such batteries, because of their compact size, permit electronic devices to be built which are very small or compact.

One mechanism by which thin profile batteries are electrically connected with other circuits or components is with electrically conductive adhesive, such as epoxy. Yet in some applications, a suitably conductive bond or interconnection is not created in spite of the highly conductive nature of the conductive epoxy, the outer battery surface, and the substrate surface to which the battery is being connected. This invention arose out of concerns associated with providing improved conductive adhesive interconnections between thin profile batteries and

conductive nodes formed on substrate surfaces. The invention has other applicability as will be appreciated by the artisan, with the invention only being limited by the accompanying claims appropriately interpreted in accordance with the Doctrine of Equivalents.

SUMMARY OF THE INVENTION

The invention in one aspect includes a thin profile battery bonding method. In one implementation, a curable adhesive composition is provided which comprises an epoxy terminated silane. A thin profile battery and a substrate to which the thin profile battery is to be conductively connected are also provided, The curable adhesive composition is interposed between the thin profile battery and the substrate. It is cured into an electrically conductive bond electrically interconnecting the battery and the substrate.

The invention in another aspect includes a method of conductively interconnecting electronic components. In one implementation, a curable adhesive composition comprising an epoxy terminated silane is provided. First and second electronic components to be conductively connected with one another are provided. The curable adhesive composition is interposed between the first and second electronic components. The adhesive is cured into an electrically conductive bond electrically interconnecting the first and second components.

The invention in still another aspect includes interposing a curable epoxy composition between first and second electrically conductive

components to be electrically interconnected. At least one of the components comprises a metal surface with which the curable epoxy is to electrically connect. The epoxy is cured into an electrically conductive bond electrically interconnecting the first and second components. The epoxy has an effective metal surface wetting concentration of silane to form a cured electrical interconnection having a contact resistance through said metal surface of less than or equal to about 0.3 ohm-cm^2.

The invention in a further aspect includes a battery powerable apparatus. In one implementation, such includes a substrate having a surface comprising at least one node location. A thin profile battery is mounted over the substrate and node location. A conductive adhesive mass electrically interconnects the thin profile battery with the node location, with the conductive adhesive mass comprising an epoxy terminated silane.

The invention in still a further aspect includes a radio frequency communication device. In one implementation, such includes a substrate having conductive paths including an antenna. At least one integrated circuit chip is mounted to the substrate and in electrical connection with a first portion of the substrate conductive paths. A thin profile battery is conductively bonded with a second portion of the substrate conductive paths by a conductive adhesive mass, with the conductive adhesive mass comprising an epoxy terminated silane.

The invention in still another aspect includes an electric circuit comprising first and second electric components electrically connected with one another through a conductive adhesive mass comprising an epoxy terminated silane.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are described below with reference to the following accompanying drawings.

Fig. 1 is a side elevational, partial cross sectional, view of a thin profile battery.

Fig. 2 is a side elevational view of a substrate.

Fig. 3 is a side elevational view of a battery powerable apparatus.

Fig. 4 is a diagrammatic plan view of a radio frequency communication device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This disclosure of the invention is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

Referring to Fig. 1, a single thin-profile battery is indicated generally with reference numeral 10. In the context of this document, "thin-profile battery" is intended to define any battery having a thickness dimension which is less than a maximum linear dimension of its anode or cathode. The preferred and illustrated battery 10 comprises a

circular button-type battery. Such comprises a lid terminal housing member 14 and a can terminal housing member 12. Can 12 is crimped about lid 14, having an insulative sealing gasket 16 interposed therebetween. In the illustrated example, gasket 16 projects outwardly slightly relative to the crimp as shown.

Fig. 2 illustrates a substrate 22 to which thin-profile battery 10 is to be conductively connected. Substrate 22 includes an outer surface 23 having one node location 24 and another node location 25 to which battery electrical connection is desired. Substrate 22, for example, can comprise a flexible circuit substrate, wherein nodes 24 and 25 comprise printed thick film ink formed on surface 23.

Referring to Fig. 3, a curable adhesive composition or mass 26 comprising an epoxy-terminated silane is interposed between lid 14 of thin profile battery 10 and substrate 22 over node location 25. Further, a curable adhesive composition or mass 32 comprising an epoxy-terminated silane is interposed between can 12 of thin-profile battery 10 and node location 24 on substrate 22. The preferred curable adhesive composition comprises a two-part epoxy resin and hardener system, wherein the preferred epoxy-terminated silane comprises a glycidoxy methoxy silane, such as a glycidoxyproplytrimethoxysilane, with 3-glycidoxyproplytrimethoxysilane being a specific example. The epoxy-terminated silane is preferably present in the curable adhesive composition at less than or equal to about 2% by weight, with less than or equal to about 1% by weight being even more preferred.

One example 3-glycidoxyproplytrimethoxysilane is available from Dow Corning Corporation of Midland, Michigan, as Z-6040™ Silane. An example resin and hardener system for a conductive epoxy is available from Creative Materials, Inc., of Tyngsboro, MA, as Part Nos. CMI 116-37A™ and CMIB-187™, respectively. In a preferred example, from 0.5 to 2.0 weight parts of Z-6040™ silane is combined with 100 weight parts of the CMI 116-37A™ silver epoxy resin. A preferred concentration of the Z-6040™ is 1 weight part with 100 weight parts of epoxy resin. Such a solution is thoroughly mixed and combined with, for example, 3 weight parts of the CMIB-187™ hardener, with the resultant mixture being further suitably mixed to form composition 26.

The composition is applied to one or both of battery 10 or substrate 22, and provided as shown in Fig. 3. An example size for conductive mass 26 is a substantially circular dot having a diameter of about 0.080 inch (0.2032 cm) and a thickness of about 0.002 inch (0.00508 cm). Resistance of a fully cured mass 26 was measured with an ohmmeter from the top of the mass to the substrate surface, which comprised a nickel-clad stainless steel Eveready CR2016™ button-type battery can. Typical measured resistance where no epoxy-terminated silane or other additive was utilized ranged from 10 ohms to 100 ohms, with in some instances resistance being as high as 1000 ohms. These correspond to respective calculated contact resistances ranging from about 0.32 ohm-cm^2 to 3.24 ohms-cm^2, with as high as 32.43 ohms-cm^2,

when ignoring the volume resistances of the epoxy mass and substrate. At the time of preparation of this document, 10 ohms (and its associated calculated contact resistance of 0.32 ohm-cm^2) is considered high and unacceptable for purposes and applications of the assignee, such as will be described with reference to Fig. 4. Yet where the epoxy-terminated silane was added, for example at a weight percent of 2% or less, the typical resistance value and range dropped significantly to 0.1 ohm to 1.0 ohm, with 0.2 ohm being typical. These correspond to respective contact resistances of about 0.0032 ohm-cm^2, 0.032 ohm-cm^2, and 0.0064 ohm-cm^2.

It is perceived that the prior art conductive bonding without the epoxy-terminated silane results from poor wetting characteristics of the conductive epoxy with the metal outer surface of the button-type battery, which typically comprises a nickel-clad stainless steel. The epoxy-terminated silane significantly improves the wetting characteristics relative to the metal surfaces, such as nickel-clad stainless steel, in a conductive epoxy system in a manner which is not understood to have been reported or known in the prior art. Accordingly in accordance with another aspect of the invention, a thin-profile battery bonding method interposes epoxy between a battery and substrate with at least one of such having a metal surface to which the curable epoxy is to electrically connect. The epoxy has an effective metal surface wetting concentration of silane to form a cured electrical interconnection having a contact resistance through said metal surface of less than or equal to

about 0.30 ohm-cm^2. More preferred, the epoxy has an effective metal surface wetting concentration of silane to form a cured electrical interconnection have a contact resistance through said metal surface of less than or equal to about 0.16 ohm-cm^2. Most preferred, such concentration provides a contact resistance of less than or equal to about 0.032 ohm-cm^2.

The curable adhesive composition is then cured into an electrically conductive bond which electrically interconnects the battery and substrate as shown in Fig. 3. In the preferred embodiment, such electrically conductive bond also is the sole physical support and connection of the battery and its terminals relative to substrate 22.

Although the invention was reduced to practice utilizing formation of a conductive interconnection between a metal battery terminal and a printed thick film on a substrate, the invention has applicability in methods and constructions of producing an electric circuit comprising other first and second electric components which electrically connect with one another through a conductive adhesive mass comprising, in a preferred embodiment, an epoxy-terminated silane.

Fig. 3 depicts an exemplary battery powerable apparatus and electric circuit 30 in accordance with an aspect of the invention. In one preferred implementation, battery powerable apparatus 30 preferably comprises a radio frequency communication device 50 as exemplified in Fig. 4. In such example, substrate 22 preferably comprises a flexible circuit substrate, with nodes 25 and 24 constituting a portion of a series

of conductive paths formed of printed thick film ink on surface 23 of flexible substrate 22. Such conductive paths includes antenna portions 54. At least one, and preferably only one, integrated circuit chip 52 is mounted relative to substrate 22 and in electrical connection with a first portion of the substrate conductive paths. Mounting is preferably with electrically conductive epoxy such as described above. Adhesive mass 26 electrically connects lid 14 of thin profile battery 10 with a second portion of the substrate conductive paths. In this example, such second portion comprises a series of printed thick film nodes 25. Conductive adhesive mass 32 electrically connects with a third portion of the substrate conductive paths, which in this example comprises node 24 in the shape of an arc.

An exemplary single integrated circuit chip is described in U.S. Patent Application Serial No. 08/705,043, which names James O'Toole, John R. Tuttle, Mark E. Tuttle, Tyler Lowery, Kevin Devereaux, George Pax, Brian Higgins, Shu-Sun Yu, David Ovard, and Robert Rotzoll as inventors, which was filed on August 29, 1996, and is assigned to the assignee of this patent application. The entire assembly 50 preferably is encapsulated in and comprises an insulative epoxy encapsulant material. Example constructions and methods for providing the same are described in a) U.S. Patent Application entitled "Battery Mounting Apparatuses, Electronic Devices, And Methods Of Forming Electrical Connections", which names Ross S. Dando, Rickie C. Lake, and Krishna Kumar as inventors, and was filed on _____, and

b) U.S. Patent Application entitled "Battery Mounting And Testing Apparatuses, Methods Of Forming Battery Mounting And Testing Apparatuses, Battery-Powered Test-Configured Electronic Devices, And Methods Of Forming Battery-Powered Test-Configured Electronic Devices", which names Scott T. Trosper as inventor, and which was filed on _____, both of which are assigned to the assignee of this patent application. Each of the above three referenced patent applications is fully incorporated herein by reference. Although this disclosure shows a single battery 10 mounted to substrate 22 for clarity and ease of description, multiple button type batteries stacked in series are preferably utilized as is collectively disclosed in the incorporated disclosures.

In compliance with the statute, the invention has been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the invention is not limited to the specific features shown and described, since the means herein disclosed comprise preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

CLAIMS:

1. A thin profile battery bonding method comprising:

providing a curable adhesive composition comprising an epoxy terminated silane;

providing a thin profile battery and a substrate to which the thin profile battery is to be conductively connected;

interposing the curable adhesive composition between the thin profile battery and the substrate; and

curing the adhesive into an electrically conductive bond electrically interconnecting the battery and the substrate.

2. The method of claim 1 wherein the epoxy terminated silane comprises a glycidoxy methoxy silane.

3. The method of claim 1 wherein the epoxy terminated silane comprises a glycidoxyproplytrimethoxysilane.

4. The method of claim 1 wherein the epoxy terminated silane is present in the curable adhesive composition at less than or equal to about 2% by weight.

5. The method of claim 1 wherein the epoxy terminated silane is present in the curable adhesive composition at less than or equal to about 1% by weight.

6. The method of claim 1 wherein the thin profile battery comprises an outer nickel clad stainless steel surface over which the curable adhesive composition is received.

7. The method of claim 1 wherein the thin profile battery is a button type battery having a terminal housing member comprising an outer nickel clad stainless steel surface over which the curable adhesive composition is received.

8. The method of claim 1 wherein the thin profile battery is a button type battery having a terminal housing member comprising an outer nickel clad stainless steel surface over which the curable adhesive composition is received, and the substrate comprises conductive printed thick film ink over which the curable adhesive composition is received.

9. A method of conductively interconnecting electronic components:

providing a curable adhesive composition comprising an epoxy terminated silane;

providing first and second electronic components to be conductively connected with one another;

interposing the curable adhesive composition between the first and second electronic components; and

curing the adhesive into an electrically conductive bond electrically interconnecting the first and second components.

10. The method of claim 9 wherein at least one of the components comprises a nickel containing metal surface over which the curable adhesive composition is received.

11. The method of claim 9 wherein the epoxy terminated silane comprises a glycidoxy methoxy silane.

12. The method of claim 9 wherein the epoxy terminated silane comprises a glycidoxyproplytrimethoxysilane.

13. The method of claim 9 wherein the epoxy terminated silane is present in the curable adhesive composition at less than or equal to about 2% by weight.

14. The method of claim 9 wherein the epoxy terminated silane is present in the curable adhesive composition at less than or equal to about 1% by weight.

15. A thin profile battery bonding method comprising:

interposing a curable epoxy composition between a thin profile battery and a substrate to which the thin profile battery is to be conductively connected, at least one of the battery and substrate comprising a metal surface with which the curable epoxy is to electrically connect; and

curing the epoxy into an electrically conductive bond electrically interconnecting the battery and the substrate, the epoxy having an effective metal surface wetting concentration of silane to form a cured electrical interconnection having a contact resistance through said metal surface of less than or equal to about 0.3 ohm-cm^2.

16. The method of claim 15 wherein the epoxy has an effective metal surface wetting concentration of silane to form a cured electrical interconnection having a resistance through said metal surface of less than or equal to about 0.16 ohm-cm^2.

17. The method of claim 15 wherein the epoxy has an effective metal surface wetting concentration of silane to form a cured electrical interconnection having a resistance through said metal surface of less than or equal to about 0.032 ohm-cm^2.

18. The method of claim 15 wherein the metal surface wetting concentration of silane in the curable adhesive composition is less than or equal to about 2% by weight.

19. The method of claim 15 wherein the metal surface wetting concentration of silane in the curable adhesive composition is less than or equal to about 1% by weight.

20. The method of claim 15 wherein the thin profile battery has the metal surface and which comprises nickel clad stainless steel over which the curable adhesive composition is received.

21. The method of claim 15 wherein the thin profile battery has the metal surface and is a button type battery having a terminal housing member comprising nickel clad stainless steel over which the curable adhesive composition is received.

22. The method of claim 15 wherein the epoxy terminated silane comprises a glycidoxy methoxy silane.

23. A method of conductively interconnecting electronic components comprising:

interposing a curable epoxy composition between first and second electrically conductive components to be electrically interconnected, at least one of the components comprising a metal surface with which the curable epoxy is to electrically connect; and

curing the epoxy into an electrically conductive bond electrically interconnecting the first and second components, the epoxy having an effective metal surface wetting concentration of silane to form a cured electrical interconnection having a contact resistance through said metal surface of less than or equal to about 0.3 ohm-cm^2.

24. The method of claim 23 wherein the epoxy has an effective metal surface wetting concentration of silane to form a cured electrical interconnection having a resistance through said metal surface of less than or equal to about 0.16 ohm-cm^2.

25. The method of claim 23 wherein the epoxy has an effective metal surface wetting concentration of silane to form a cured electrical interconnection having a resistance through said metal surface of less than or equal to about 0.032 ohm-cm^2.

26. The method of claim 23 wherein the metal surface wetting concentration of silane in the curable adhesive composition is less than or equal to about 2% by weight.

27. The method of claim 23 wherein the metal surface wetting concentration of silane in the curable adhesive composition is less than or equal to about 1% by weight.

28. The method of claim 23 wherein the metal surface comprises nickel over which the curable adhesive composition is received.

29. A battery powerable apparatus comprising:

a substrate having a surface comprising at least one node location;

a thin profile battery mounted over the substrate and node location; and

a conductive adhesive mass electrically interconnecting the thin profile battery with the node location, the conductive adhesive mass comprising an epoxy terminated silane.

30. The apparatus of claim 29 wherein the epoxy terminated silane comprises a glycidoxy methoxy silane.

31. The apparatus of claim 29 wherein the epoxy terminated silane comprises a glycidoxyproplytrimethoxysilane.

32. The apparatus of claim 29 wherein the epoxy terminated silane is present in the adhesive mass at less than or equal to about 2% by weight.

33. The apparatus of claim 29 wherein the epoxy terminated silane is present in the adhesive mass at less than or equal to about 1% by weight.

34. The apparatus of claim 29 wherein the thin profile battery comprises an outer nickel clad stainless steel surface over which the conductive adhesive mass is received.

35. The apparatus of claim 29 wherein the thin profile battery is a button type battery having a terminal housing member comprising an outer nickel clad stainless steel surface over which the conductive adhesive mass is received.

36. The apparatus of claim 29 wherein the thin profile battery is a button type battery having a terminal housing member comprising an outer nickel clad stainless steel surface over which the conductive adhesive mass is received, and the substrate comprises conductive printed thick film ink over which the conductive adhesive mass is received.

37. A radio frequency communication device comprising:

a substrate having conductive paths including an antenna;

at least one integrated circuit chip mounted to the substrate and in electrical connection with a first portion of the substrate conductive paths; and

a thin profile battery conductively bonded with a second portion of the substrate conductive paths by a conductive adhesive mass, the conductive adhesive mass comprising an epoxy terminated silane.

38. The device of claim 37 wherein the epoxy terminated silane comprises a glycidoxy methoxy silane.

39. The device of claim 37 wherein the epoxy terminated silane comprises a glycidoxyproplytrimethoxysilane.

40. The device of claim 37 wherein the epoxy terminated silane is present in the adhesive mass at less than or equal to about 2% by weight.

41. The device of claim 37 wherein the epoxy terminated silane is present in the adhesive mass at less than or equal to about 1% by weight.

42. The device of claim 37 wherein the thin profile battery comprises an outer nickel clad stainless steel surface over which the conductive adhesive mass is received.

43. The device of claim 37 wherein the thin profile battery is a button type battery having a terminal housing member comprising an outer nickel clad stainless steel surface over which the conductive adhesive mass is received.

44. The device of claim 37 wherein the thin profile battery is a button type battery having a terminal housing member comprising an outer nickel clad stainless steel surface over which the conductive adhesive mass is received, and the conductive paths comprise conductive printed thick film ink over the second portion of which the conductive adhesive mass is received.

45. An electric circuit comprising first and second electric components electrically connected with one another through a conductive adhesive mass comprising an epoxy terminated silane.

46. The electric circuity of claim 45 wherein the epoxy terminated silane comprises a glycidoxy methoxy silane.

47. The apparatus of claim 45 wherein the epoxy terminated silane comprises a glycidoxyproplytrimethoxysilane.

48. The apparatus of claim 45 wherein the epoxy terminated silane is present in the adhesive mass at less than or equal to about 2% by weight.

49. The apparatus of claim 45 wherein the epoxy terminated silane is present in the adhesive mass at less than or equal to about 1% by weight.

50. The apparatus of claim 45 wherein at least one of the first and second electric components comprises a nickel containing metal surface over which the conductive adhesive mass is received.

ABSTRACT OF THE DISCLOSURE

A curable adhesive composition is provided which comprises an epoxy terminated silane. A thin profile battery and a substrate to which the thin profile battery is to be conductively connected are also provided. The curable adhesive composition is interposed between the thin profile battery and the substrate. It is cured into an electrically conductive bond electrically interconnecting the battery and the substrate. In another aspect, the invention includes a method of conductively interconnecting electronic components using a curable adhesive composition which comprises an epoxy terminated silane. The invention in another aspect includes interposing a curable epoxy composition between first and second electrically conductive components to be electrically interconnected. At least one of the components comprises a metal surface with which the curable epoxy is to electrically connect. The epoxy is cured into an electrically conductive bond electrically interconnecting the first and second components. The epoxy has an effective metal surface wetting concentration of silane to form a cured electrical interconnection having a resistance through said metal surface of less than or equal to about 0.3 ohm-cm^2. In another aspect, a battery powerable apparatus includes a conductive adhesive mass comprising an epoxy terminated silane between a battery and substrate. A radio frequency communication device is one example. In another aspect, the invention includes an electric circuit comprising first and second electric components electrically connected with one another

through a conductive adhesive mass comprising an epoxy terminated silane.

MI40-123

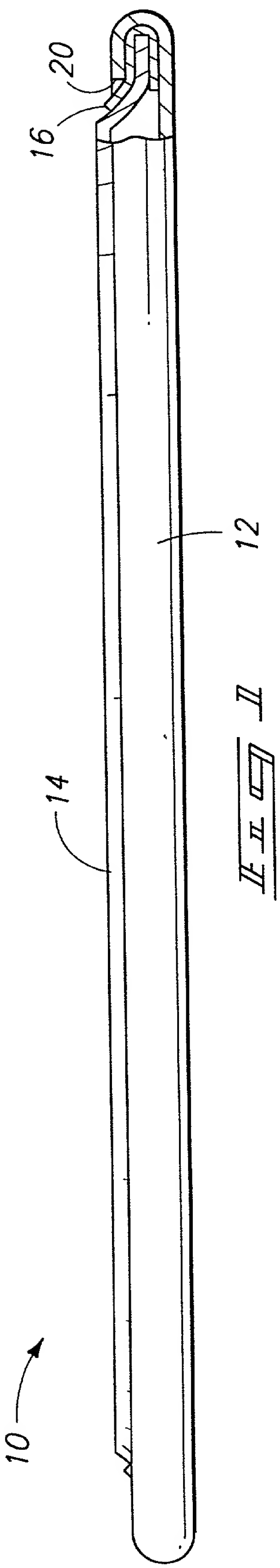

Fig 1

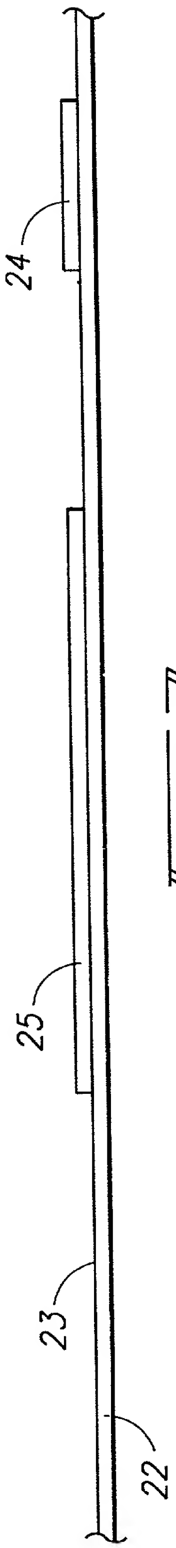

Fig 2

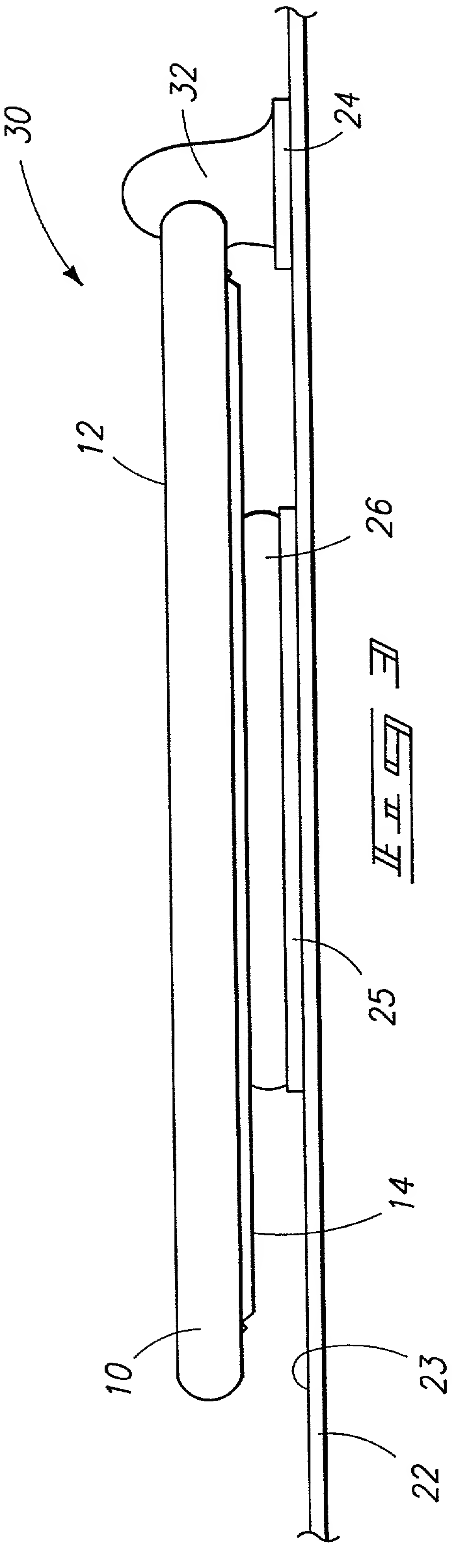

Fig 3

MI40-123

AS FILED

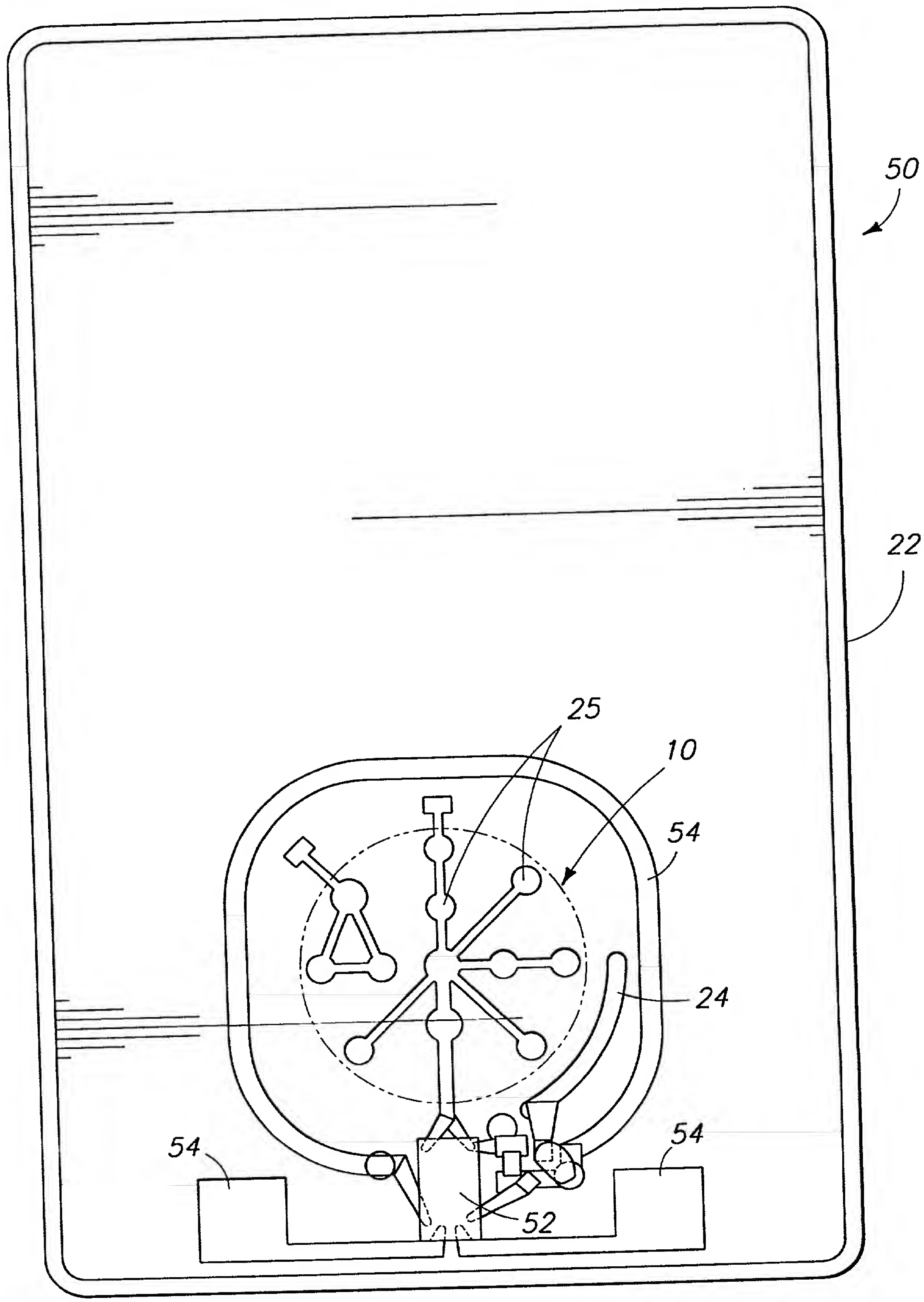

Fig 4

DECLARATION OF SOLE INVENTOR FOR PATENT APPLICATION

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: **Thin Profile Battery Bonding Method, Method Of Conductively Interconnecting Electronic Components, Battery Powerable Apparatus, Radio Frequency Communication Device, And Electric Circuit,** the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations §1.56.

PRIOR FOREIGN APPLICATIONS:

I hereby state that no applications for foreign patents or inventor's certificates have been filed prior to the date of execution of this declaration.

POWER OF ATTORNEY:

As a named Inventor, I hereby appoint the following attorneys and agent to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Richard J. St. John, Reg. No. 19,363; David P. Roberts, Reg. No. 23,032; Randy A. Gregory,

Reg. No. 30,386; Mark S. Matkin, Reg. No. 32,268; James L. Price, Reg. No. 27,376; Deepak Malhotra, Reg. No. 33,560; Mark W. Hendricksen, Reg. No. 32,356; David G. Latwesen, Reg. No. 38,533; George G. Grigel, Reg. No. 31,166; Keith D. Grzelak, Reg. No. 37,144; John S. Reid, Reg. No. 36,369; Lance R. Sadler, Reg. No. 38,605; James D. Shaurette, Reg. No. 39,833; Lia Pappas Dennison, Reg. No. 34,095; and Michael L. Lynch, Reg. No. 30,871.

Send correspondence to: WELLS, ST. JOHN, ROBERTS, GREGORY & MATKIN P.S., 601 W. First Avenue, Suite 1300, Spokane, WA 99201-3817. Direct telephone calls to: Mark S. Matkin (509) 624-4276.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statement may jeopardize the validity of the application or any patent issued therefrom.

* * * * * * * * * *

Full name of sole inventor: **Rickie C. Lake**

Inventor's Signature: ______________________

Date: 2-4-98

Residence: **Eagle, Idaho**

Citizenship: **U.S.A.**

Post Office Address: **338 Pebble Beach Ct.**
Eagle, ID 83616